User's Manual

Analog Time-Division Multiplexer

SD0703

Advisor: Dr. David Farden

Landon Wagner
Matthew Fryslie

Contents

List of Figures

1 Introduction:

The most difficult task in running the Analog Time-Division Multiplexer (ATDM) is wiring the system together. In the end wires are running every which-way and setup can be confusing the first time or two. This is unavoidable since the system is spread across six different printed circuit boards (pcb). However, there are only three types of connections to be made on the system. They are;

1. Power-supply connections
    - Reference voltage - used on all pcb's
    - +5 V - used on all pcb's
    - -5 V - used on Sample & Hold\Low-Pass Filter pcb's only
    - +2.5 V - used on Multiplexer\Demultiplexer pcb's only
    - -2.5 V - used on Multiplexer\Demultiplexer pcb's only
      Note: How to connect the power supplies, as well as digital and analog signal connections will be illustrated with pictures later in the manual.
2. Digital-signal connections: These are primarily the signals running from the Multiplexer (Demultiplexer) pcb's that control the states of the sample & hold circuits.
3. Analog-signal connections: These are the connections that, in the case of the multiplexer, run from the output of the sample & hold circuits to the multiplexer input channels. Or in the demultiplexer these are the connections that run from the ouputs of the demultiplexer chip to the input of the sample & hold circuits.

And that is it! After taking one trip through the user's manual you'll be an expert in wiring the system together.

To begin, let's define the individual boards so it is easier to recognize what is being referred to throughout the document. The boards are defined as follows:

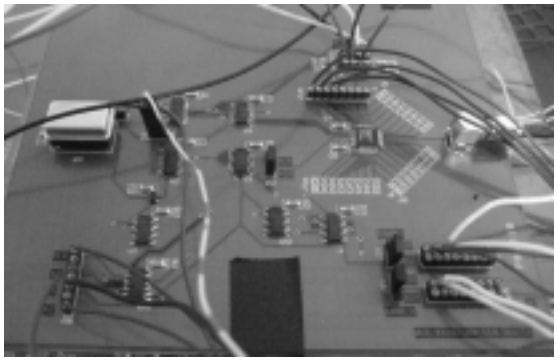

Figure 1: Multiplexer board, note the crystal on this board.

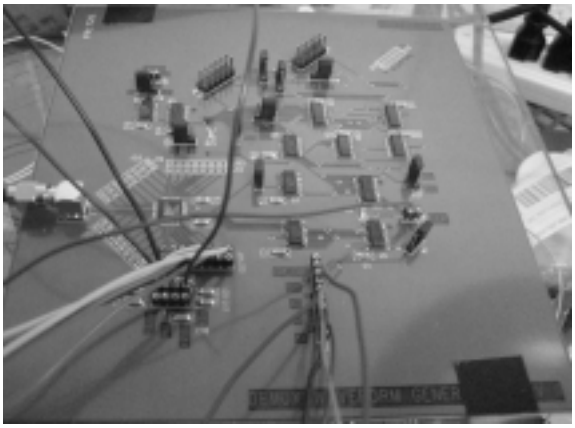

Figure 2: Demultiplexer board, note the lack of a crystal on this board.

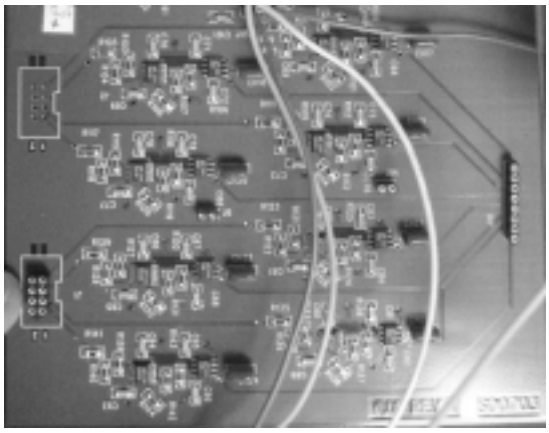

Figure 3: Mux Channels 0 to 15, note this board has one sample\hold chip per channel.

Figure 4: Mux Channels 16 to 31, note this board has two sample\hold chips per channel.

2 Power Connections:

To begin, a dedicated power supply such as the HY3002-3 model found in all labs is needed to run the ATDM. This is because all 112 sample\hold chips and all 64 low pass filters require ±5V supplies. The CADET's -5V supply cannot provide enough current to run that many chips.

There are a few different ways to get power to the boards and the user can feel free to use their own method; the only thing to note is, as stated above, if using a CADET the -5V supply cannot keep up to the demand. However, the

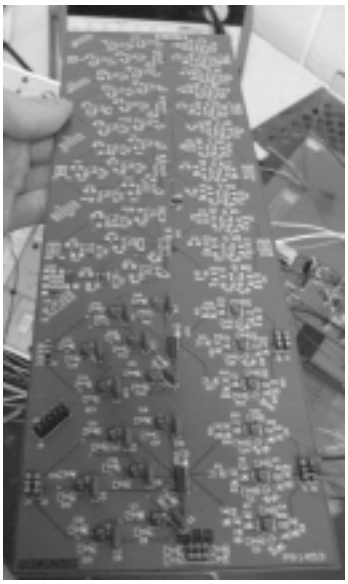

Figure 5: Demux Channels 0 to 15, note this board is *really* long.

CADET should be able to provide all other supplies.

If you want to use the CADET with the HY3002-3 DC supply: This is probably the easiest method as all labs have at least one CADET and HY3002-3 DC power supply so no equipment will need to be borrowed.

1. Using a multi-meter, set the positive and negative variable supplies on the CADET to ±2.5V.

2. On the lower right of the HY3002-3 DC supply there are two terminals with the text "5V FIXED 3A" above them. Connect the ***RED*** terminal of the DC supply to ***"GROUND"*** terminal on the CADET. Now, the DC supply's ***BLACK*** terminal is -5V with respect to the CADET supplies.

3. For you convenience you may want to run a lead from the DC power supply's ***BLACK*** terminal to a row on the CADET's breadboard to branch multiple -5V supply leads to the pcb's.

Now that the power supply is taken care of we can focus on connecting the nets.

Note that all pcb's except two have silkscreen markings next to the power supply pins telling the user what pin belongs to what net(see below).

The two pcb's that do not are "Mux Channels 0-15" and "Mux Channels 16-31". These were the first to be designed and at that time it did not occur to the layout designer to include the markings.

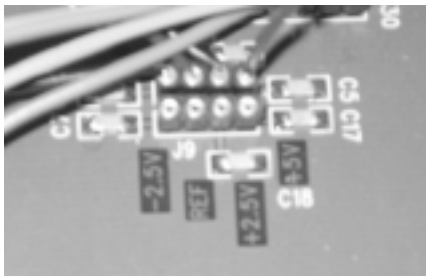

Figure 6: Power supply silkscreen markings

So, for the "Mux Channels 0-15" board with no silkscreen markings, the correct terminals are as follows (note that the pins are marked on a white peice of paper taped to the board as well):

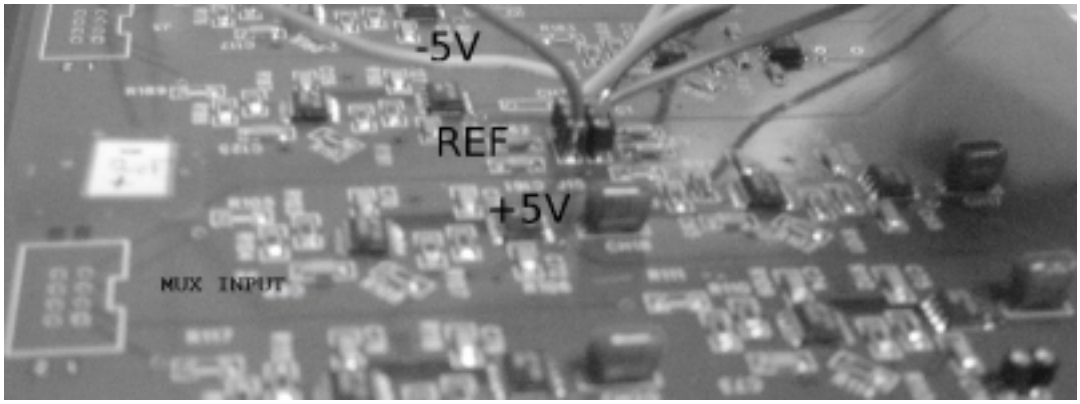

Figure 7: Power Supply Pins for "Mux Channels 0-15"

For the "Mux Channels 16-31" board with no silkscreen markings, the correct terminals are as follows (note that the pins are marked on a white peice of paper taped to the board as well):

Now that all pins have been identified, the user is free to wire the supplies together.

Note: Each board has two pins for each supply. This was done in case daisy-chaining the boards, one after the other, is convenient for the user.

This takes care of setting up the power supplies. Remember, the -5V supply on the CADET is not enough to power the boards, a dedicated DC source must be used.

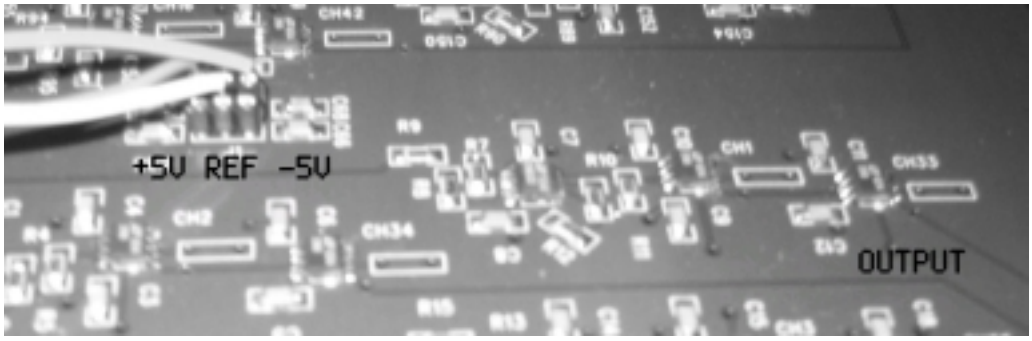

Figure 8: Power Supply Pins for "Mux Channels 16-31"

3 Digital-Signal Connections:

These are the connections connecting the waveform generation circuitry to the sample\hold logic on both the Multiplexer and Demultiplexer as well as the Demultiplexer analog switch.

3.1 Multiplexer boards:

1. Let's begin with the sample\hold logic on "Mux Channels 0 to 15" board. This board only requires a Bank 1 waveform. See below to see where the Bank 1 waveform is generated on the Multiplexer board. The Bank 1 Silkscreen label is somewhat obscured in the picture but it is still visible. *Note: only the top row is connected to Bank 1. The lower row is connected to REF. This can easily be seen on the board by the trace only running from the logic output to the socket.*

   Find the sockets shown in the image below on the "Mux Channels 0-15" board. Connect these sockets to the Bank 1 waveform sockets (there are plenty!).
   Note: Only the pins closest to the inputs are connected to the sample\hold logic pins. The other pins are connected to REF.

2. Moving to the sample\hold logic on the "Mux Channels 16 to 31" board. Refer to two figures above to view where the Bank 2 waveform is generated (and don't forget where the Bank 1 waveform is generated, we still need that!).

   Find the sockets shown in the image below on the "Mux Channels 16 to 31" board. Connect the appropriate sockets to the Bank 1,2 sockets.
   Note: On this board, unlike "Mux Channels 0 to 15", both pins carry a signal.

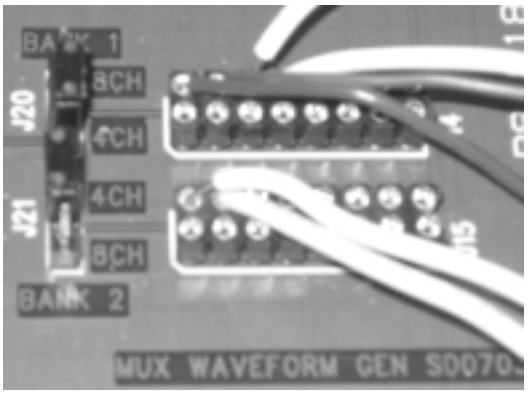

Figure 9: Photo illustrating "Bank 1" and "Bank 2" connections on the Multiplexer board.

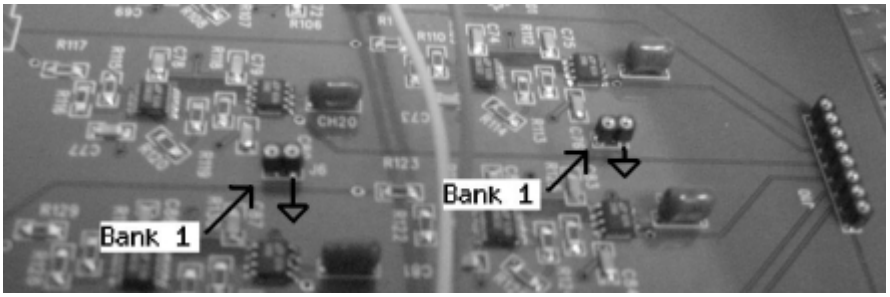

Figure 10: Photo illustrating logic pins on "Mux Channels 0 to 15".

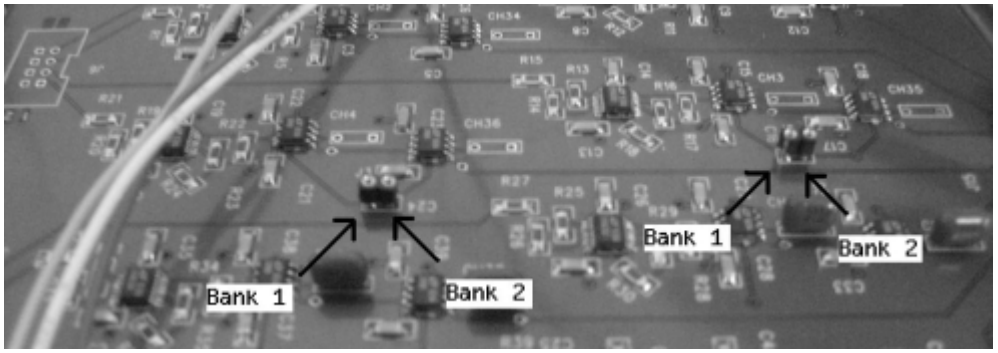

Figure 11: Photo illustrating logic pins on "Mux Channels 16 to 31".

This takes care of all digital signals on the Multiplexer that don't run *between* the multiplexer and demultiplexer boards; we'll cover those later.

3.2 Demultiplexer boards:

1. The easiest way to make these connections is to use ribbon cable as seen in the picture. There are so many sample\hold signals between the boards that individual wires would be a major headache.

   View Figures 12 and 13 to see how to make these connections.

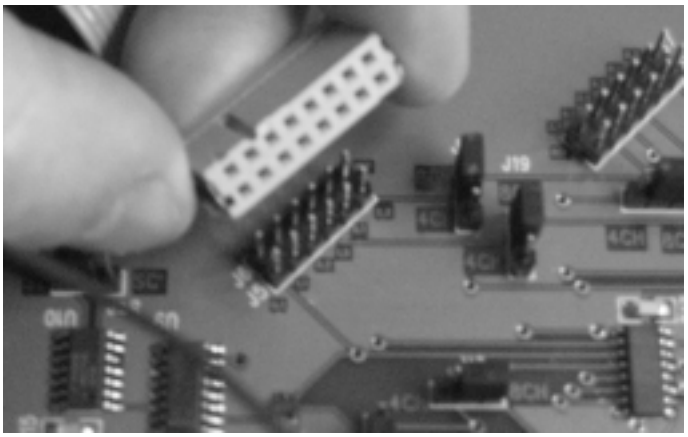

Figure 12: Photo illustrating connection to be made on the Demultiplexer board.

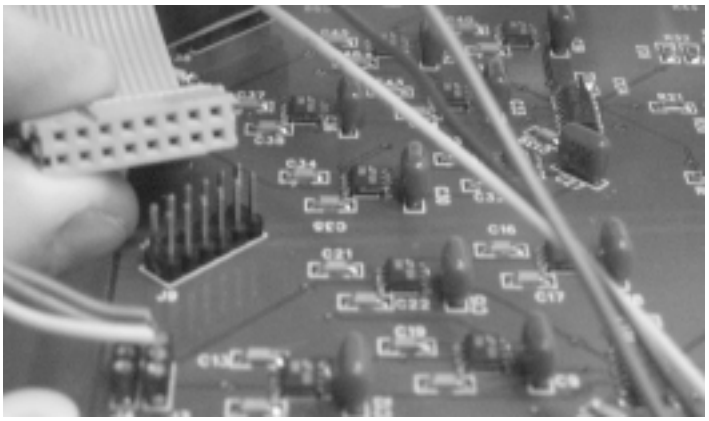

Figure 13: Photo illustrating connection to be made on the "Demux Channels 0 to 15" board.

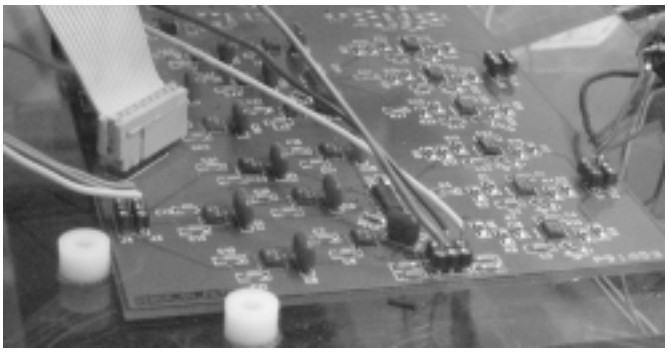

Figure 14: Photo illustrating connection after it has been made on the Demux Channels 0 to 15 board.

The left-most header on the Demultiplexer board corresponds to the bottom-most header on the Demux Channels 0 to 15 board as the photos are viewed.

2. Now we need to connect the analog switch control between the Demultiplexer boards. The connections to be made are shown in Figures 15 to 16.

   Note: On the Demux Channels 0 to 15 board, the analog switch pin is the pin on the header closest to the sample\hold circuits. The other is tied to REF.

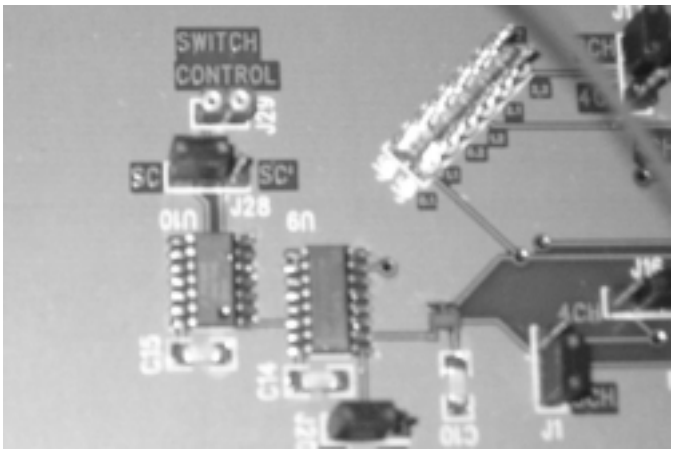

Figure 15: Photo illustrating the analog switch connection to be made on the Demultiplexer board.

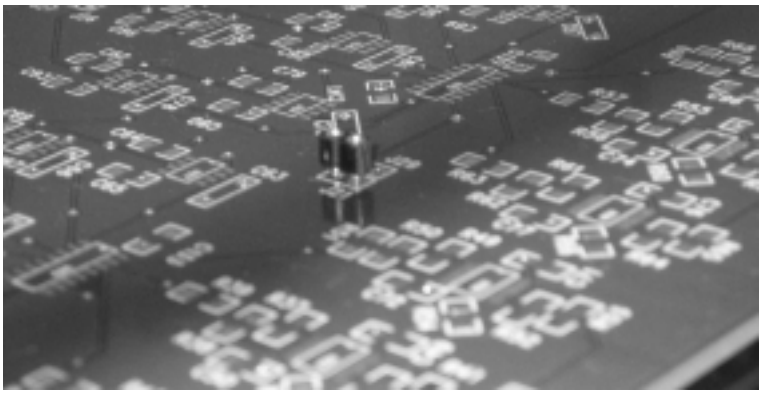

Figure 16: Photo illustrating the analog switch connection to be made on the "Demux Channels 0 to 15" board. The furthest pin is active.

3.3 Digital signals shared between Multiplexer and Demultiplexer boards:

The only crucial signal shared between the two is the clock signal from the crystal. The connection to be made can be seen below.

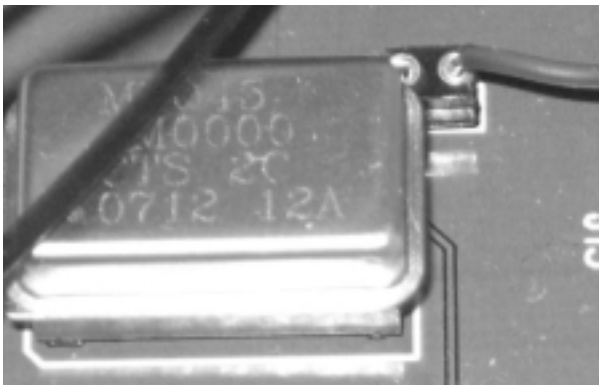

Figure 17: Photo illustrating the Multiplexer clock socket to connect to the Demultiplexer clock socket.

Staying in synchronization between the channels on the Multiplexer and Demultiplexer should not be an issue. However, if the user is having problems there is a counter-action. This would be to implement the bit-comparison circuit. The purpose of this is to compare the levels of the control bits between the boards and reset all counters if and when they fall out of synch. This just involved connecting a few more wires between the boards.

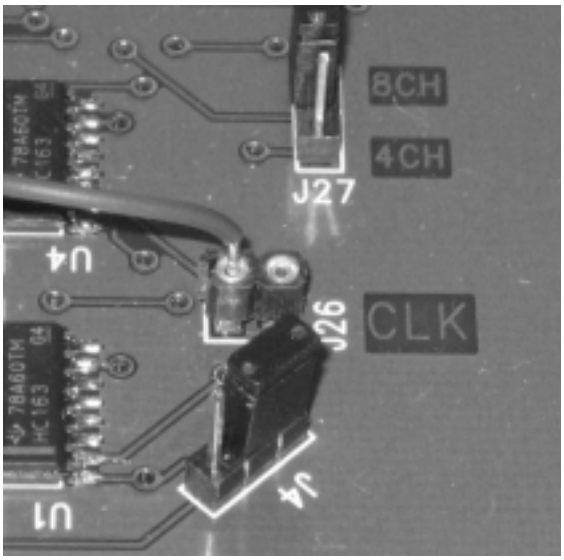

Figure 18: Photo illustrating the Demultiplexer clock socket to connect to the Multiplexer clock socket.

The sockets allowing an interface between the state of the Clock signal as well as A0, A1, and A2 are clearly marked on each board and the user simply has to run a wire between each socket. See Figures 19 and 20 to see photos of the markings.

Note: Depending on whether you are using the bit-comparison circuitry or not, there are some jumpers that need to be set. See Figure 18 to view the difference. In the current (upper) position the bit comparison circuit is not being used. Also, you can see on the board that the trace connected to the reset command (lower) pin is unconnected; the upper pin is +5V.

Also, regarding this issue, see Figure 21 to see the corresponding jumper on the Multiplexer board. In the figure, the jumper is set to ignore the bit-comparison circuitry. This can be seen by the traces shown in the figure as well.

The Demultiplexer board has a socket dedicated to receiving the "Counter Reset" command if needed (the bit-comparison circuitry is on the Multiplexer board), but the Multiplexer board has no socket dedicated to sending the command. To get around this oversight, please see Figure 21 to see how the designer solved the issue. Shown is a female header with the leads shorted together to one lead. This lead is run to the Demultiplexer socket labeled CLR_CMD.

This takes care of all digital signals. The last we have to connect is the analog signals between the board.

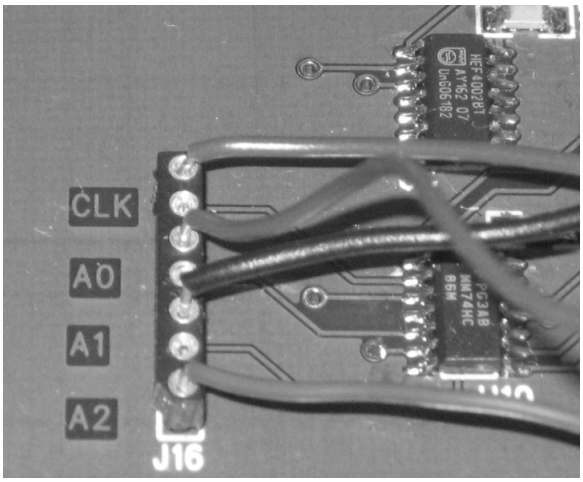

Figure 19: Photo illustrating the sockets to connect to the Multiplexer bit-comparison sockets.

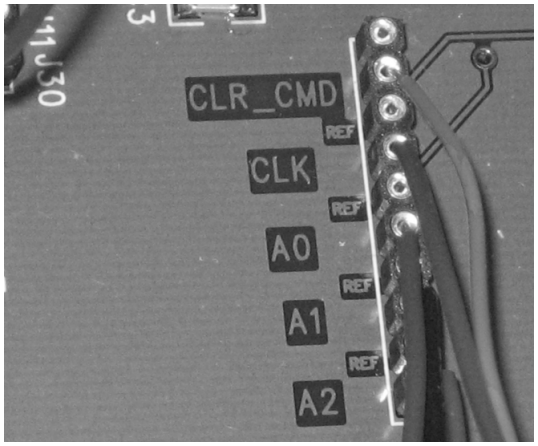

Figure 20: Photo illustrating the sockets to connect to the Demultiplexer bit-comparison sockets.

4 Analog-Signal Connections:

This part of the setup should be the most headache free.

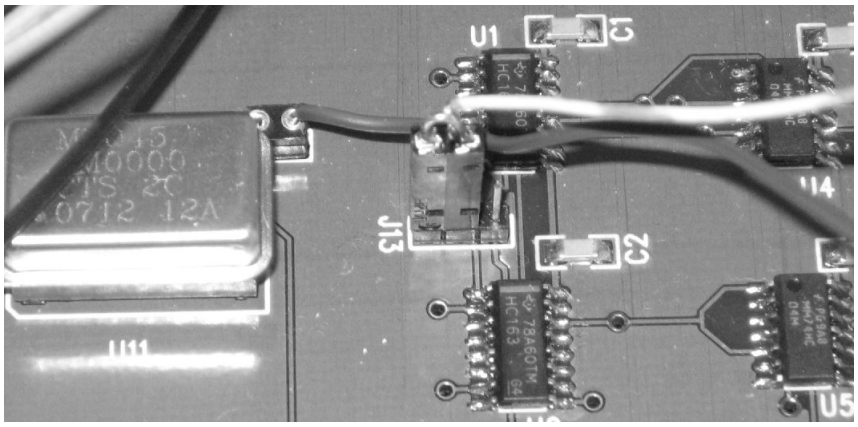

Figure 21: Photo illustrating the Multiplexer "Counter reset" output.

4.1 Regarding "Mux Channels 0-15, 16-31", Multiplexer Chip

You can use any convenient channel on the Multiplexer data acquisition boards you choose, with one constraint. For a four channel setup, two channels must be from "Mux Channels 0-15" and these must be wired to channels 0 and 1 on the multiplexer chip. Also, two channels must be from "Mux Channels 16-32" and these must be wired to channels 2 and 3 on the multiplexer chip.

The same idea holds for an eight channel setup, four channels must be split between each board.

4.2 Regarding "Demux Channels, all", Multiplexer Chip

This setup is even less constrained, any parallel sample\hold and low-pass filter network may be used.

5 Multiplexer\Demultiplexer boards

The last step is to ensure that all jumpers on the board are set.

The jumpers controlling the number of channels used should all either be set to 4 or 8 channels.

There are three jumpers that enable or disable the bit-comparison circuitry. I highlighted two of them earlier in the document, the third is near the analog switch output on the Demultiplexer board. The terminals are labeled "vcc" and "rst". To enable the circuitry, the jumper should be placed on "rst".